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MKS

Instruction Manual

TYPE 258C/1258C/2258C MASS FLOW METERS

TYPE 1259C/2259C MASS FLOW CONTROLLERS

SIX SHATTUCK ROAD, ANDOVER, MASSACHUSETTS 01810 (508) 975-2350 TELEX 910-240-6005 FAX (508) 975-0093

MKS INSTRUMENTS, INC.

WARRANTY

MKS Instruments, Inc. (MKS) warrants that all equipment manufactured by **MKS** shall be free from defects in materials and workmanship for a period of one year from date of shipment. For the period commencing with the date of shipment of the equipment and ending one year later, **MKS** will, at its option, either repair or replace any part which is defective in materials or workmanship without charge to the purchaser. The foregoing shall constitute the exclusive and sole remedy of the purchaser for any breach by **MKS** of this warranty.

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TYPE 258C/1258C/2258C
MASS FLOW METERS

TYPE 1259C/2259C
MASS FLOW CONTROLLERS

SECTION 1
GENERAL DESCRIPTION AND SPECIFICATIONS

1.1 GENERAL

The MKS Flow Meter/Controller series of instruments accurately measures and controls the mass flow rate of gases. Based upon a patented measurement technique,* the instrument provides fast response and maintains excellent long-term stability.

The mechanical design reflects attention to field serviceability in that the instrument may be easily disassembled and reassembled without significant calibration shift. Furthermore, the design incorporates a Card Edge Type D shielded connector, metal cover, RF bypass capacitors, and proper layout to virtually eliminate RFI and EMI interference. A feature added to the controller is its ability to accept TTL level commands that remotely open or close the control valve.

The Flow Controller Instrument family may be powered, setpoint commanded, and displayed by complimentary MKS equipment (Models 112, 147, 160, 246, 247) or by user supplied devices. Refer to their respective manuals for the appropriate information.

1.2 MECHANICAL CONFIGURATIONS

The MKS Flow Instruments are modular in concept and are available in a variety of models and configurations to suit specific needs.

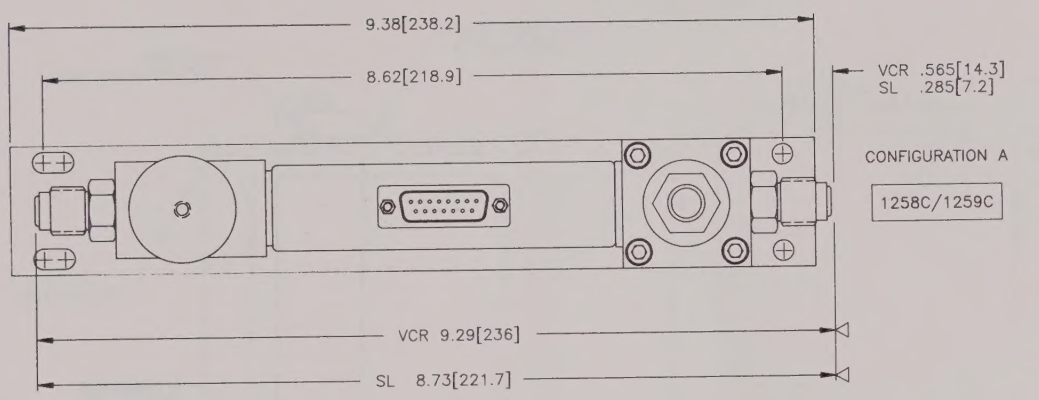
The following basic models are available:

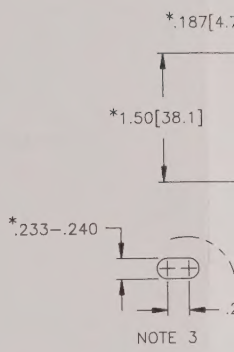
1) Mass Flow Meter (258C)
2) Mass Flow Meter w/proportional control valve (1258C)
3) Mass Flow Controller w/Type D Connector (1259C)

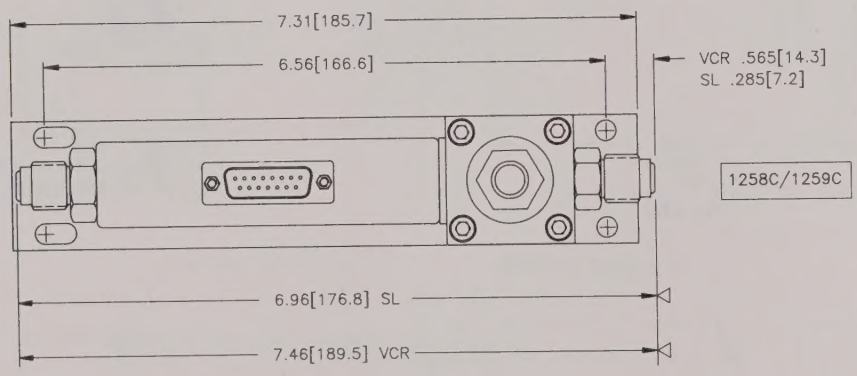
The following configurations are available:

4) 1258C Flow Meter and valve with a Nupro[1] [R] positive shut-off valve downstream (2258C)
5) 1259C Flow Controller with a Nupro[1] positive shut-off valve downstream (2259C)
6) 2258C, 2259C with a positive shut-off valve upstream (2259C Configuration A)

* U.S. Patent No. 4,464,932
[1] Nupro is a registered trademark of the Nupro Company







CONTROLL
(C.C

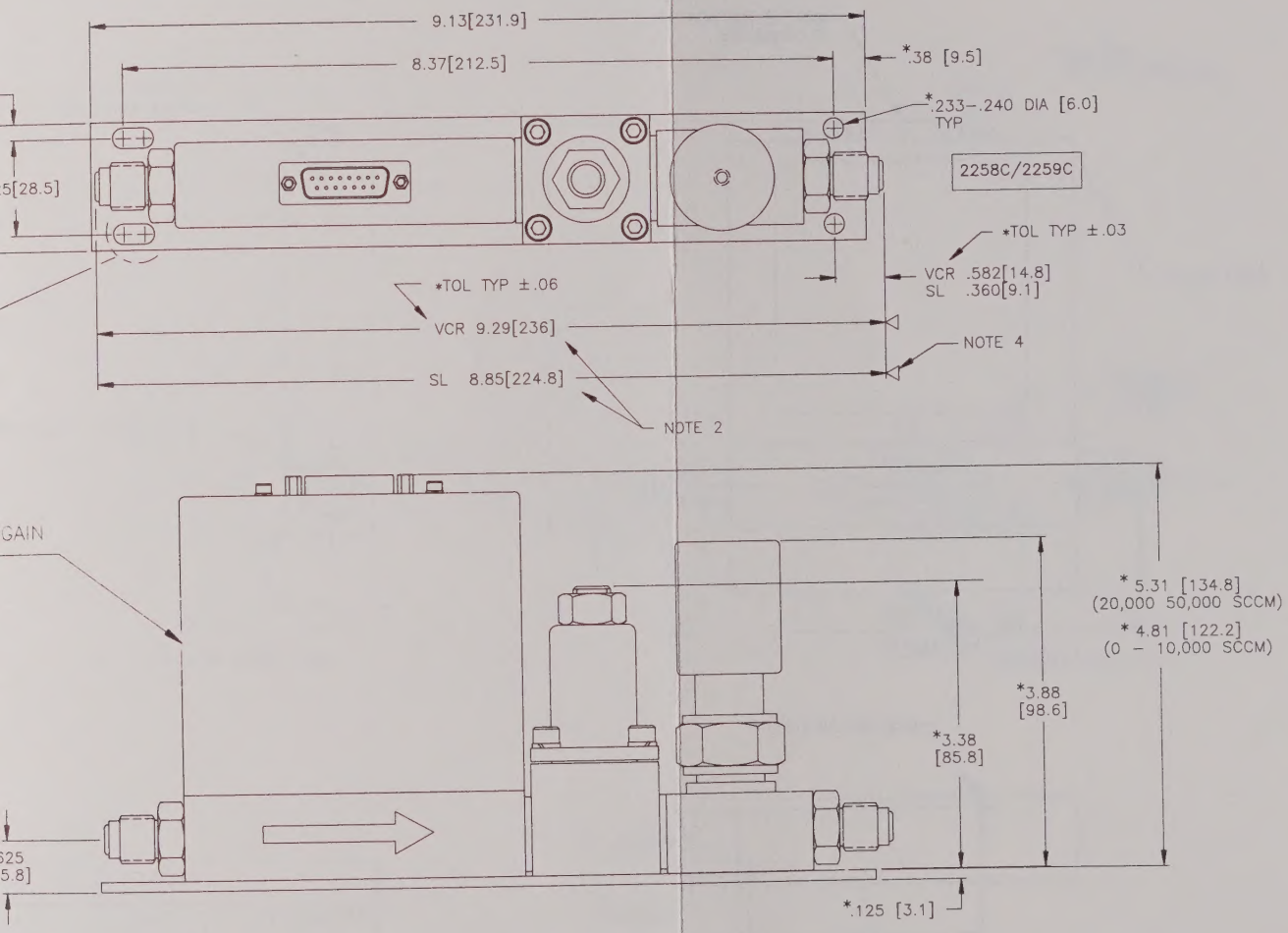
4. ◁ = ADD .250 [6.3] FOR 20,000 & 50,000 SCCM UNITS.

3. INSTALLATION NOTE:
   UNITS WITH FLOWMETER/CONTROLLER RANGE OVER 10,000 SCCM MUST USE MAXIMUM LENGTH MOUNTING HOLE DIMENSION.

2. FITTING DIMENSIONS:
   2.1 VCR DIMENSIONS ARE FROM MATING FACE TO MATING FACE.
   2.2 SWAGELOK (SL) DIMENSIONS ARE FROM FITTING END TO FITTING END (LESS NUT). EACH FITTING HAS A .31 MAX. TUBE INSERTION DEPTH.

1. UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE NOMINAL VALUES IN INCHES [MM REF].

NOTES:

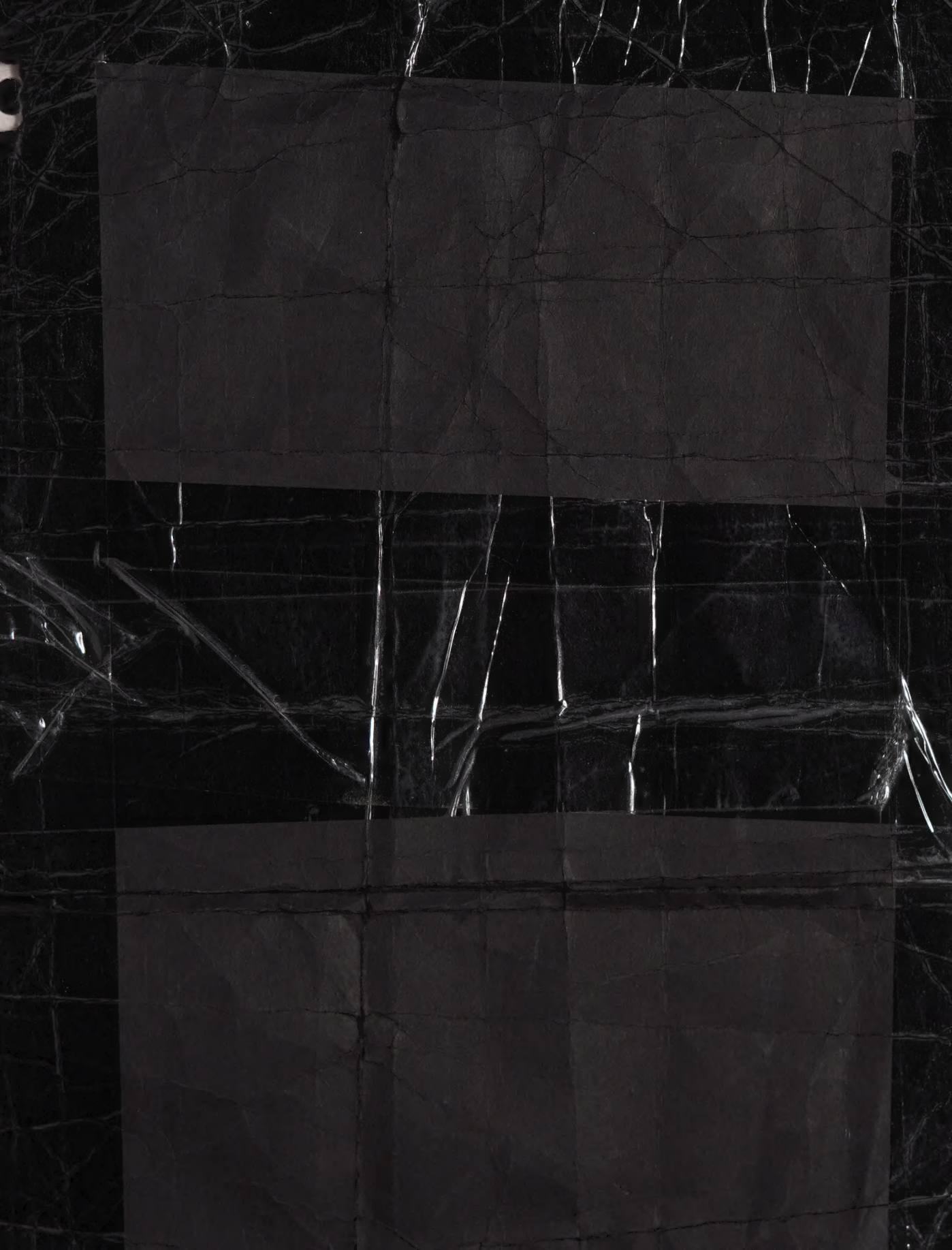


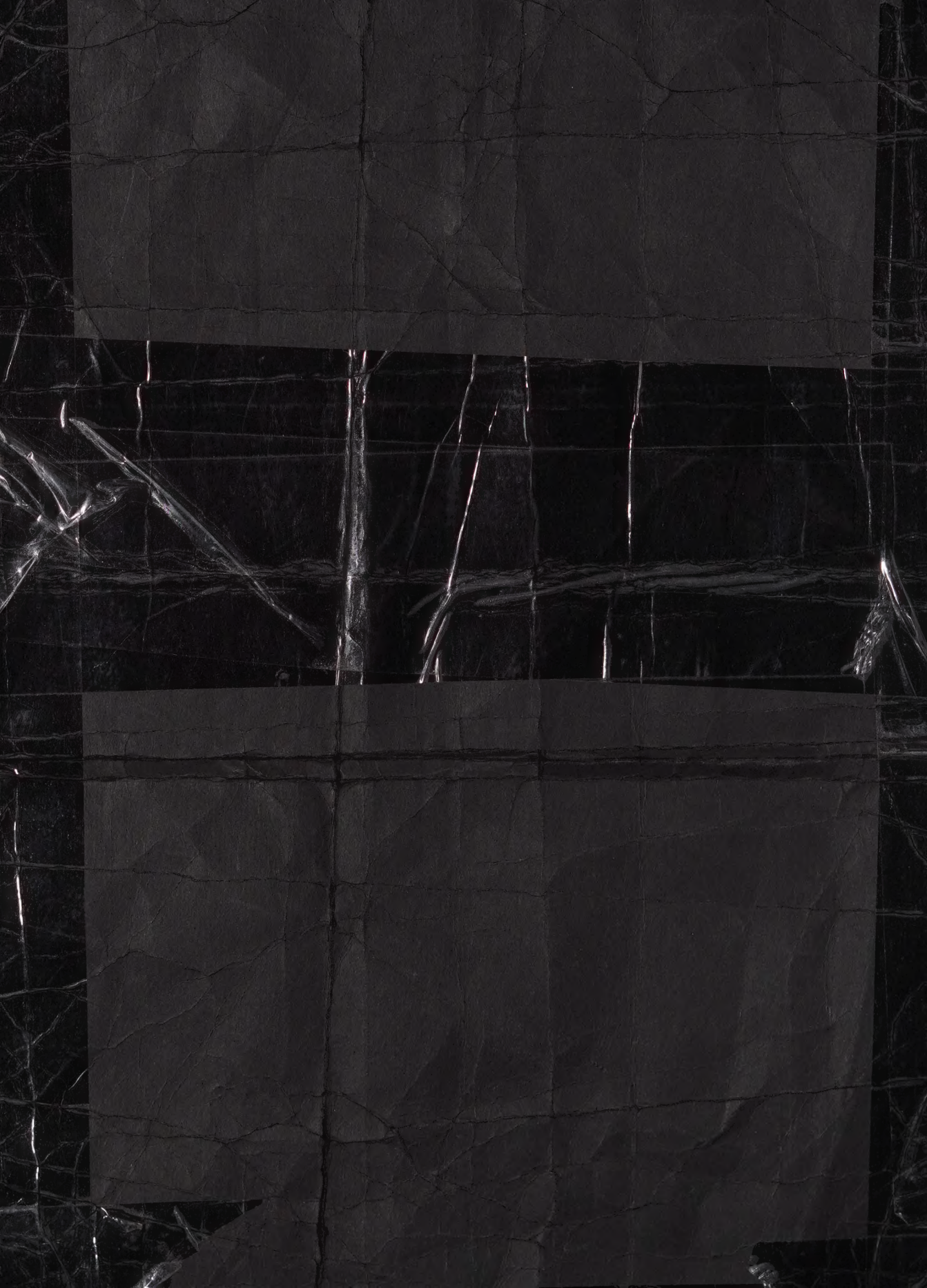
* DIMENSIONS INDICATED BY * APPLY TO ANY CONFIGURATION

OUTLINE DRAWING

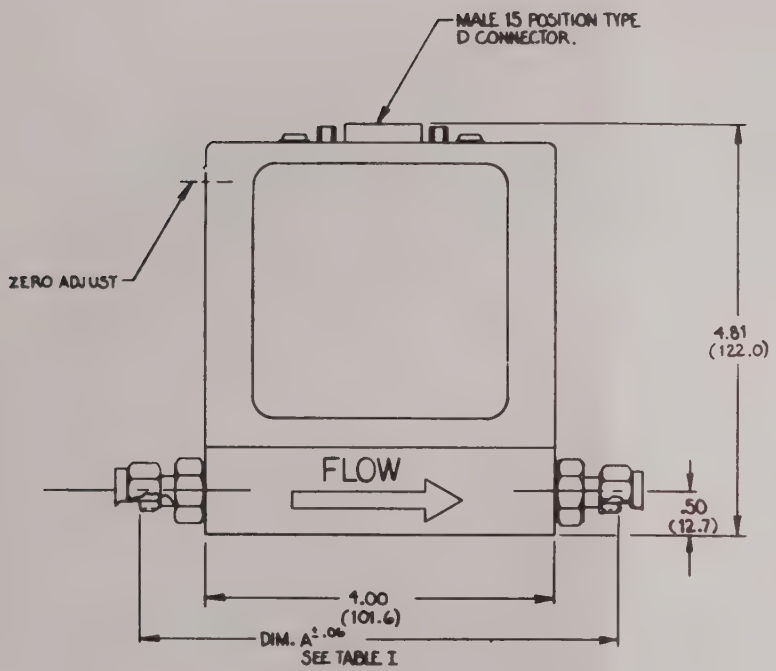
1258C/1259C/2258C/2259C

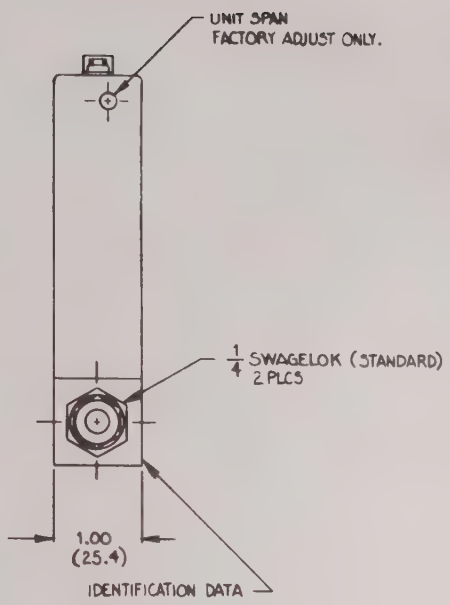
111388C





10 THRU 10K RANGE





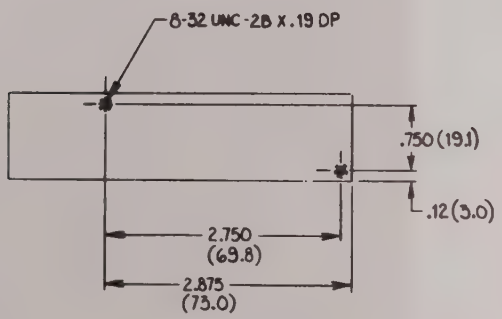
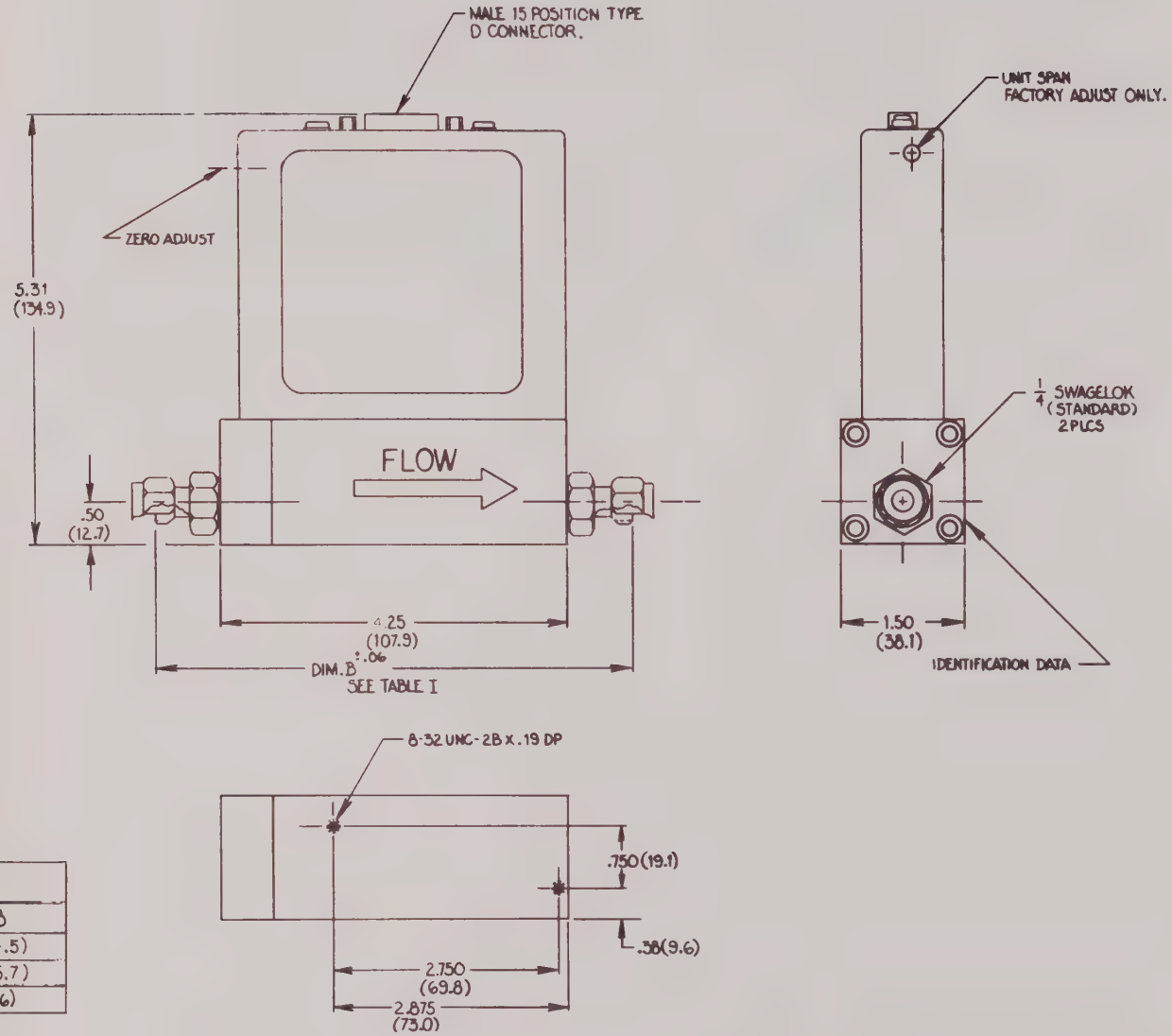


TABLE I		
FITTING TYPE	DIM. A	DIM
SWAGELOK	5.44 (138.2)	5.69
4 VCR (NOTE 2)	5.88 (149.4)	6.13
4 VCO (NOTE 2)	5.56 (141.2)	5.81

NOTES:

1. UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE NOMINAL VALUES IN INCHES (MM REF).
2. 4VCR & 4VCO FITTINGS:
   MALE ON BOTH ENDS
   MATING GLANDS, GASKETS & NUTS TO BE SUPPLIED BY CUSTOMER.

20K AND 50K RANGE



OUTLINE DRAWING

258C

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1.3 Specifications

	High Accuracy 258C/1258C/2258C 1259C/2259C
Performance Specifications	
Full Scale Ranges	10, 20, 50, 100, 200, 500, 1000, 2000, 5000, 10,000, 20,000, 50,000 sccm
Control Range[1]	1.5 to 100% of F.S.
Accuracy (incl. non-linearity)[2]	±0.8% of F.S.
Resolution (measurement)	0.1% of F.S.
Temperature Coefficients	
Zero	<0.05% of F.S./°C (500 ppm)[3]
Span	<0.10% of Rdg./°C
Operating Temperature Range	15° to 40°C
Warm-up Time[6]	30 minutes
Settling Time[1]	<2 sec. to within 2% of set point
Maximum Inlet Pressure	150 psig.
Pressure Coefficient	0.005% of Rdg./psi
Minimum Pressure Drop[4]	5 Torr at atmosphere
Electrical Specifications	
Input Voltage/Current Required	
Max. at start up	±15 VDC @ 250mA
Typical at steady state	±15 VDC @ 160mA
Input/Command Signal[1]	0-5 VDC from < 20K Ω source
Output Signal/Minimum Load	0-5 VDC into > 10K Ω source
Output Impedance	<1 Ω
Connector Type	RF shielded Type "D"
Mechanical Specifications	
Materials Wetted	
Standard	316SS, Nickel, Viton
Optional	Buna-N, Neoprene, or Kalrez
Leak Integrity	
External	$\leq 10^{-9}$ scc/sec. He
Through closed valve[5]	$\leq 10^{-7}$ scc/sec. He
Fittings	
Standard	¼" Swagelok
Optional	Cajon 4 VCR (male), Cajon 4 VCO (male)

[1] Controller Only
[2] Calibration Referenced to 760 Torr/0°C (Semi Standard)
[3] Zero temperature coefficients for 10 and 20 sccm units is 0.5% of F.S./°C
[4] Meter only
[5] 1258C/1259C only
[6] Consult factory for 10 sccm units

1.4 THEORY OF OPERATION

Flow Path

The MKS Flow Controller Instrument series are laminar flow devices whose precise indication of mass flow is achieved through the use of a range controlling changeable bypass and a paralleling sensor tube. Upon entering the Flowmeter/Controller, the gas stream is divided into two parallel paths; the first is directed through the sensor tube, the second through the changeable bypass. The two paths are then rejoined to pass through the control valve before exiting the instrument. The two paths possess an L/D ratio of greater than 100:1, assuring laminar flow. With proper flow calibration equipment available, field-range changing is possible.

Measurement Technique

The amount of energy required to maintain a fixed temperature profile along a tube through which laminar flow is occurring is a function of mass-flow rate. In the MKS mass flow meter, resistance heaters are wound on the sensor tube and form the active legs of bridge circuits. Their temperatures are established such that a voltage change on the sensor winding is a linear function of a flow change. This signal is then amplified to provide a 0-5 VDC output. Improved response times are observed because the output need not wait for a new temperature equilibrium to be established along the flow tube. A patent has been issued to MKS on this technique.

Tailored Control Circuitry

The flow controller uses the above measurement technique and includes control circuitry which provides drive current for the proportioning control valve. The flow controller accepts a 0-5 VDC setpoint signal, compares it to its own flow signal, and generates an error voltage. This error signal is then conditioned (derivative, proportional, and integral gain) and that it may reposition the controlling valve, thus reducing this error to within the accuracy specification of the instrument. This error will normally be less than .05% of full scale flow.* However, this error is a function of process dynamics; meaning, the noisier the process, the greater the average error (deviation of flow signal and setpoint). The MKS Type 112, 147, 246, and 247 are designed to power, provide setpoint, and display the output of the flow controller.

* This is the controller error and must not be confused with the instrument's measurement error (see specifications).

Control Valve

The Control Valve is a specially constructed solenoid valve wherein the armature (moving valving mechanism) is suspended with two springs. This location mechanism assures that no friction is present thus making precise control possible. A control current is used to lift the armature from the seat thus allowing the controlled flow of gas. NOTE: (THIS IS NOT AN ON/OFF VALVE.) Variations of less than one micro-amp are necessary to give the control resolution obtainable with an MKS system.

An adjustable control orifice located on the bottom of the valve varies the closing force which allows for any small adjustments that may be necessitated by swelling or aging of the elastomeric seating material.

- CAUTION -

THIS ADJUSTMENT IS DELICATE AND ANY MORE THAN ± 1/8 TURN FROM NOMINAL (FACTORY SETTING) WILL BE EXCESSIVE.

SECTION 2

INSTALLATION

2.1 MECHANICAL INSTALLATION - MOUNTING

General

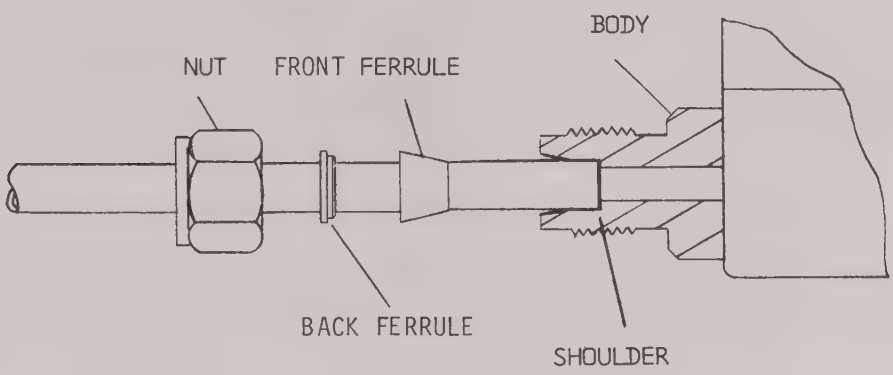
1) Horizontal mounting of flow components is preferred. Mounting of flow components in other than a horizontal position will cause a small zero shift, Section 3-1.

2) The instrument must be installed in the gas stream such that the flow will be in the direction of the arrow on the side of the base.

3) Be sure to allow for connector clearance, access to zero potentiometer, and access to the seat adjustment in the base of the 248A/B Control Valve.

2.2 Mechanical Installation - Gas Line Connection
Standard Fittings

Swagelok® compression fittings (1/4 inch) are standard. Tubing used should be clean and free of axial scratches. The tubing should be inserted through the compression nut and ferrules all the way to the shoulder as shown below.



- CAUTION -

Tighten nut only 1-1/4 turns past finger tight. When remaking, tighten nut 1/6 turn only. Overtightening will damage tubing and fitting, and destroy a normally leak-tight fitting.

Optional Fittings

Cajon® male 4 VCR/4 VCO Fittings are available as standard options, when specified.

Swaglock® is a registered product trademark of Crawford Fitting Company.

Cajon® is a registered product trademark of the Cajon Company.

2.3 Electrical Installation

For use of the Flow Meter/Controller Series instruments with any equipment other than complimenting MKS modules, the manufacturers' specifications should be consulted for connection, and proper electrical and power characteristics. Refer to Section 1.3 for electrical requirements of MKS flow instruments.

Signal-Pin Correspondence of Type D connector.

Pin #	Signal
1	MKS Test Point*
2	Flow Signal Output
3	Valve Close*
4	Valve Open*
5	Power Common
6	-15 VDC
7	+15 VDC
8	Set Point Input*
9	No Connection
10	Optional Input*
11	Signal Common
12	Signal Common
13	No Connection
14	No Connection
15	Chassis Ground

* Controller only

Interface Cables

Certain interface cables can be supplied by MKS, or the user may choose to make them up according to individual needs, provided the appropriate specifications contained herein are maintained.

1. Complete MKS Flow System (Flow Meters/Controllers/Power Supply/Readouts)

   For convenience, when a customer purchases a complete mass flow meter/control system, specifying all companion MKS equipment at time of purchase, MKS will supply the appropriate cable(s) with connectors, in standard lengths at a nominal cost.

2. Interface Cables for Non-MKS Power Supplies/Readouts

   Shielded cable assemblies, in a nominal 10' (3M) length, with "D" Type connector on one end and terminated in "flying leads" (pigtail) fashion on the other end are available at nominal cost.

   Note: 1) Shielded cable assemblies are recommended, especially if environment contains high EMI/RFI noise.

   Note: 2) Be sure to provide adequate clearance for "D" Type cable assemblies:

   - Straight Shielded connectors require approximately 3" height.
   - Right Angle connectors require approximately 2" height.

SECTION 3

OPERATION

3.1 OPERATION OF MODEL 258C/1258C/1259C MASS FLOW CONTROLLER

After proper gas and electrical connections have been made,* the following procedure should be used to put the instrument into operation.

Warm-Up

When power is first applied, the output will be +7.5 VDC. After being powered for a minute or so, the output will start dropping rapidly as the tube heaters reach control temperature. The instrument reading with no flow approaches zero output as the heaters stabilize. Measurements can be made within 10 minutes of turn-on. After 30 minutes from start, the instrument may be re-zeroed and the span will read correctly. Check zero periodically to establish its reliability.

Zeroing

A. With no gas flow assured, zero the output of the MFC using the zero pot as marked on the input side. Note: Zero should be set in same plane of orientation that it will be mounted in system.

B. When used with an MKS 112, 147, 160, 246, or 247, it is only necessary to zero at the indicator, as this zeroed signal is sent to the controller section of the Flow Controller. If one runs out of adjustment in the readout, use the zero pot of meter/controller located on the upstream side.

MFC Use and Application of Gas Correction Factor (GCF)

A. After zeroing, the MFC will provide a 0-5 VDC output corresponding to 0-100 percent nitrogen flow of meter rating, unless a special calibration has been called out at the time of ordering.

CAUTION:

System should be properly leak checked before operation.

B. This 0-5 VDC output should be interpreted for other gases, as follows:

$$\frac{\text{Output}}{5.000 \text{ F.S.}} \times \text{Range of Instrument} \times \text{GCF*} = \text{Flow of Gas Used}$$

Example: Output = 3.22 VDC

Range = 500 sccm N_2

Gas Corr. Factor (CCL_4) = 0.31

$$\text{Flow} = \frac{3.22\text{V} \times 500 \times .31}{5.000} = 100 \text{ sccm } CCL_4$$

C. If interpretation of the output is undesirable and the readout equipment has no GCF potentiometer, a proper input divider can be constructed. (Note: MKS Models 112, 147, 246, 247 and 260 instruments provide gas correction factor adjustment.)

D. The 0-5 VDC flow signal output comes from pin 2 and is referenced to Pin 12 which is signal common.

E. Any appropriate 0-5 VDC input signal of less than 20K Ω source impedance referenced to Pin 12 can be used to supply a setpoint signal to Pin 8.

F. The 1259C Controller has been equipped with a circuit that makes response to a small setpoint command very rapid (<2 secs.). At setpoints of less than 10%, there is some overshoot. The integrated flow for this period of time divided by the elapsed time (1.5 secs.) will be less than the setpoint flow rate. If this overshoot is harmful to the process, consult the factory for disabling instructions.

G. Use of the MFC is now routine except that if power to it is interrupted, the warming period should be observed.

* Gas Corr. Factor - See Section 5

Valve Override (Controller only)

Valve override permits the user to fully open (purge) or close the control valve independent of the setpoint command signal.

- To OPEN valve, apply a TTL low to Pin 4, or connect Pin 4 to Pin 11 (signal common).

- To CLOSE valve, apply a TTL low to Pin 3, or connect Pin 3 to Pin 11.

When both Valve Close and Valve Open are pulled down, the valve will be open at a setting of flow that is somewhat less than the full scale range of that controller.

CAUTIONARY NOTES

NOTE 1 MKS SUPPLIED POWER SUPPLY/DISPLAY EQUIPMENT

When the 1259C is used with an MKS 147, 246 or 247, Note 2 2 does not apply. The 147, 246 or 247B takes the flow signal from the 1259C, zeroes it with the front panel zero pot, and sends the signal back to the controller section of the 1259C on Pin 10.

NOTE 2 USER SUPPLIED DISPLAY EQUIPMENT

It is important to note that the controller section of the 1259C compares its own flow signal with the setpoint signal, and positions the valve to reduce this error to zero. Therefore, it is necessary to zero the flow transducer's output, using its zero potentiometer, rather than offsetting a non-zero signal with an equal and opposite signal in the readout equipment, if it is so equipped. Failure to properly zero the transducer will result in a disparity of setpoint and flow signals equal to the zero offset.

NOTE 3 SETPOINT COMMAND

The use of a setpoint voltage source of low impedance (<20K Ω) is necessary for concurrence between setpoint and flow signal output.

NOTE 4 GENERAL

A controller is a device that acts upon the value of an error signal (that of setpoint vs. actual flow). If the setpoint is above the flow signal (positive in relation to the setpoint) then the valve will be opened. If both signals are more negative than -.5 VDC, but S.P. is more positive than the F.S, then the valve will be opened. And as most controllers use an integral mode, the longer the error endures, the more the valve will be opened.

SECTION 4

TROUBLESHOOTING

4.1 TROUBLESHOOTING CHART

Symptoms	Possible Cause	Remedy
No output or over-range at zero (after warm up)	Flow is on and above meter range	Isolate Mass Flow Controller from Flow Channel
	Cable improper	Check cable for type and damage
	Electronics	Return for service
Unit indicates approx. twice known flow and is unstable	Unit installed in gas stream backwards	Reinstall unit in proper flow direction
Controller does not track	Improper zero adjustment	Zero meter output as described in Section 3
Controller does not function	Valve misadjusted	Readjust valve
	Valve override function applied	Disconnect
	Electronics	Return for service
Unit produces large pressure drop or will not pass full flow	Clogged Sensor tube and/or bypass	Return for service
Unit exhibits large temp. coef.	Electronics	Return for service
		Check placement of flow meter in hot system
Unit is non-linear or exhibits erratic operation	Electronics	Return for service
Oscillation	Too high a controller gain setting	Reduce (turn counter-clockwise)
	Incorrect upstream pressure regulator	Check manufacturers specifications

SECTION 5

MAINTENANCE

5.1 GENERAL

Should any difficulties be encountered in the use of your instrument, it is recommended that you contact any MKS Service Center for repair instructions.

IF IT IS NECESSARY TO RETURN THE INSTRUMENT TO MKS FOR REPAIR, PLEASE CONTACT ANY MKS SERVICE/CALIBRATION CENTER LISTED ON THE INSIDE OF THE BACK COVER FOR AN ERA NO. (EQUIPMENT RETURN AUTHORIZATION NUMBER) TO EXPEDITE HANDLING AND ASSURE PROPER SERVICING OF YOUR INSTRUMENT.

5.2 ORIFICE ADJUSTMENT

With no power applied, the valve should have no measurable leakage or flow when the valve is positioned vertically, base down, and 1 atmosphere differential pressure greater than the specification is applied. Should unacceptable leakage exist because of different operating conditions or normal wear, adjustment is achieved by turning the Orifice Assembly adjustment Screw in the base clockwise.

IMPORTANT

Turn orifice 5°-10° at a time, each time observing a change in leakage.

Turn orifice an additional 10°-15° beyond the threshold of acceptable leakage. Excessive clockwise adjustment may reduce maximum flow control or impair control response.

If the leakage cannot be corrected by Orifice Assembly adjustment, the problem is one of the following:

(1) Leaky seat - replace the Armature/Plug Assembly
(2) Leaky Orifice Assembly Seal - replace seals or assembly.
(3) Scored, pitted body - inspect, replace as required

NEVER screw the Orifice Assembly hard up to the Armature/Plug Assembly. Damage requiring replacement of either or both assemblies will result.

ALWAYS disconnect the valve from its controller when adjusting for orifice leakage as valve bias misadjustment may hold the valve partially open.

SECTION 6

GAS CORRECTION FACTORS AND METER SELECTION

6.1 GENERAL

The gas correction factor (GCF) is a number used to indicate the ratio of flow rates of different gases which will produce the same output voltage from a flowmeter. Experience has shown that these values are theoretical and actual flows cannot be guaranteed.* The GCF is a function of specific heat, density, and molecular structure of the gases. If nitrogen is used as the base-line gas (GCF=1), the GCF of any other gas is found by using the equation:

$$C_x = \frac{.3106\ S}{p_x Cp_x}$$

where:

C_x	=	GCF of gas X
p_x	=	Density if gas X at 0°Cm gms/liter
Cp_x	=	Specific heat of gas X, cal/gm°C
.3106	=	pCp for nitrogen at 0°C
S	=	Molecular Structure correction factor

Molecular Structure	S
Monatomic Gases	1.030
Diatomic Gases	1.000
Triatomic Gases	0.941
Polyatomic Gases	0.880

TABLE OF VALUES
OF
MOLECULAR STRUCTURE CORRECTION FACTORS

* MKS is in the process of verifying and correcting the values for its flowmeter technology using our Califlow® Primary Flow Standards. It is unclear at present whether or not our work will be applicable to other Thermal Mass flow meters.

Example:

Flowmeters calibrated with N_2 are available in ranges of 10 to 50,000 sccm. It is desired to flow 100 sccm of CCl_4; which meter should be chosen?

1. Look up GCF for CCl_4 - .31

2. Apply the ratio of GCF's to determine the equivalent of N_2 (X). $\frac{1.00}{.31} = \frac{X}{100}$; X = 323 sccm

3. 100 sccm of CCl_4 will look like 323 sccm of N_2. This falls within the range of a 500 sccm unit: therefore, it should be selected.

4. If, for example, we had calculated 600 sccm instead of 323, one would still choose the 500 sccm meter, as any meter may be respanned to a maximum of 120% of its nominal rating and remain linear.

The following Chart includes values of GCF for commonly used gases.

Gas Flow Conversion Chart

GAS	SYMBOL	SPECIFIC HEAT, Cp cal/g°C	DENSITY g/l @ 0°C	CONVERSION FACTOR
Air	-----	.240	1.293	1.00
Ammonia	NH_3	.492	.760	.73
Argon	Ar	.1244	1.782	1.37[1]
Arsine	AsH_3	.1167	3.478	.67
Boron Trichloride	BCl_3	.1279	5.227	.41
Bromine	Br_2	.0539	7.130	.81
Carbon Dioxide	CO_2	.2016	1.964	.70[1]
Carbon Monoxide	CO	.2488	1.250	1.00
Carbon Tetrachloride	CCl_4	.1655	6.86	.31
Carbon Tetrafluoride (Freon – 14)	CF_4	.1654	3.926	.42
Chlorine	Cl_2	.1144	3.163	.86
Chlorodifluoromethane (Freon – 22)	$CHClF_2$	.1544	3.858	.46
Chloropentafluoroethane (Freon – 115)	C_2ClF_5	.164	6.892	.24
Chlorotrifluoromethane (Freon – 13)	$CClF_3$	.153	4.660	.38
Cyanogen	C_2N_2	.2613	2.322	.61
Deuterium	D_2	1.722	.1799	1.00
Diborane	B_2H_6	.508	1.235	.44
Dibromodifluoromethane	CBr_2F_2	.15	9.362	.19
Dichlorodifluoromethane (Freon – 12)	CCl_2F_2	.1432	5.395	.35
Dichlorofluoromethane (Freon – 21)	$CHCl_2F$	.140	4.592	.42
Dichloromethylsilane	$(CH_3)_2SiCl_2$	.1882	5.758	.25
Dichlorosilane	SiH_2Cl_2	.150	4.506	.40
1,2 – Dichlorotetrafluoroethane (Freon – 114)	$C_2Cl_2F_4$	.160	7.626	.22
1,1 – Difluoroethylene (Freon – 1132A)	$C_2H_2F_2$	.224	2.857	.43
2,2 – Dimethylpropane	C_5H_{12}	.3914	3.219	.22
Ethane	C_2H_6	.4097	1.342	.50
Fluorine	F_2	.1873	1.695	.98
Fluoroform (Freon – 23)	CHF_3	.176	3.127	.50
Freon – 11	CCl_3F	.1357	6.129	.33
Freon – 12	CCl_2F_2	.1432	5.395	.35
Freon – 13	$CClF_3$	.153	4.660	.38
Freon – 13 B_1	$CBrF_3$	.1113	6.644	.37
Freon – 14	CF_4	.1654	3.926	.42
Freon – 21	$CHCl_2F$	.140	4.592	.42
Freon – 22	$CHClF_2$	.1544	3.858	.46
Freon – 23	CHF_3	.176	3.127	.50
Freon – 113	$C_2Cl_3F_3$	.161	8.360	.20
Freon – 114	$C_2Cl_2F_4$	.160	7.626	.22
Freon – 115	C_2ClF_5	.164	6.892	.24
Freon – 116	C_2F_6	.1843	6.157	.24
Freon – C318	C_4F_8	.185	8.397	.17

Gas Flow Conversion Chart (Cont'd.)

GAS	SYMBOL	SPECIFIC HEAT, Cp cal/g°C	DENSITY g/l @ 0°C	CONVERSION FACTOR
Freon - 1132A	$C_2H_2F_2$	.224	2.857	.43
Helium	He	1.241	.1786	1.454 [2]
Hexafluoroethane (Freon - 116)	C_2F_6	.1843	6.157	.24
Hydrogen	H_2	3.419	.0899	-- [2]
Hydrogen Bromide	HBr	.0861	3.610	1.00
Hydrogen Chloride	HCl	.1912	1.627	1.00
Hydrogen Fluoride	HF	.3479	.893	1.00
Isobutylene	C_4H_8	.3701	2.503	.29
Krypton	Kr	.0593	3.739	1.543
Methane	CH_4	.5328	.715	.72
Methyl Fluoride	CH_3F	.3221	1.518	.56
Molybdenum Hexafluoride	MoF_6	.1373	9.366	.21
Neon	Ne	.246	.900	1.46
Nitric Oxide	NO	.2328	1.339	.99
Nitrogen	N_2	.2485	1.250	1.00
Nitrogen Dioxide	NO_2	.1933	2.052	.74
Nitrogen Trifluoride	NF_3	.1797	3.168	.48
Nitrous Oxide	N_2O	.2088	1.964	.71
Octafluorocyclobutane (Freon - C318)	C_4F_8	.185	8.937	.17
Oxygen	O_2	.2193	1.427	1.00
Pentane	C_5H_{12}	.398	3.219	.21
Perfluoropropane	C_3F_8	.194	8.388	.17
Phosgene	$COCl_2$	.1394	4.418	.44
Phosphine	PH_3	.2374	1.517	.76
Propane	C_3H_8	.3885	1.967	.36
Propylene	C_3H_6	.3541	1.877	.41
Silane	SiH_4	.3189	1.433	.60
Silicon Tetrachloride	$SiCl_4$	.1270	7.580	.28
Silicon Tetrafluoride	SiF_4	.1691	4.643	.35
Sulfur Dioxide	SO_2	.1488	2.858	.69
Sulfur Hexafluoride	SF_6	.1592	6.516	.26
Trichlorofluoromethane (Freon - 11)	CCl_3F	.1357	6.129	.33
Trichlorosilane	$SiHCl_3$	.1380	6.043	.33
1, 1, 2 - Trichloro - 1, 2, 2 Trifluoroethane (Freon - 113)	CCl_2FCClF_2 $C_2Cl_3F_3$	.161	8.360	.20
Tungsten Hexafluoride	WF_6	.0810	13.28	.25
Xenon	Xe	.0378	5.858	1.32

[1] Empirically defined
[2] Consult MKS for special applications

NOTE: Standard Pressure is defined as 760 mmHg (14.7). Standard Temperature is defined as 0°C.

SECTION 7

POSITIVE SHUT-OFF VALVE
MKS Part No. A108157

GENERAL

A Nupro 4BK series pneumatically operated valve may be used in series with the Mass Flow Controller when a no-leakage condition is required. Since the spring force is very low in the MKS Flow Controller, leak tightness cannot be guaranteed using this valve alone. The Nupro valve is an all 316 SS bellows seal valve using a Kel-F valve seat. It has a maximum leak rate across the ports of $3x10^{-8}$ sccm H_e and a leak rate of less than $1x10^{-9}$ sccm H_e to the outside. It is available in both N.O. and N.C. versions that require 50 to 150 psi air to operate. Unless otherwise specified it will be supplied with a 2258/2259 in the N.C. mode requiring air pressure to open.

INSTALLATION

The MKS version of the Nupro 4BK valve is close-coupled to the 2258/2259 Series. The assembly is attached to an aluminum plate which is to be mounted preferably to a horizontal surface. Vertical mounting is acceptable but a correctable zero offset of the flowmeter will result. (See previous section for proper fitting make-up). The air operator port is a 1/8 FNPT. As this valve has no adjustments, mounting for easy access need not be a serious consideration.

OPERATION

Applying and removing the air pressure to the valve is all that is necessary to ensure the open and closed condition. No attempt should be made to control flow using this valve.

Calibration and Maintenance Services

Standard maintenance services are available at all of our regional MKS Calibration and Service Centers in North America, Europe, U.K., Japan, and Korea. MFC's can receive new seals, a range change (if needed), and re-calibration. As an extended courtesy, MKS accepts the instruments of other manufacturers for recalibration using the Primary and Transfer Standard calibration equipment located at all of our regional service centers. Our service centers are organized to offer long-term service contracts to minimize turnaround time by reducing the administrative steps of a large number of small orders usually associated with maintenance work.

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